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SYNTONIC SPACE TELEGRAPHY.

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Fig. 1.

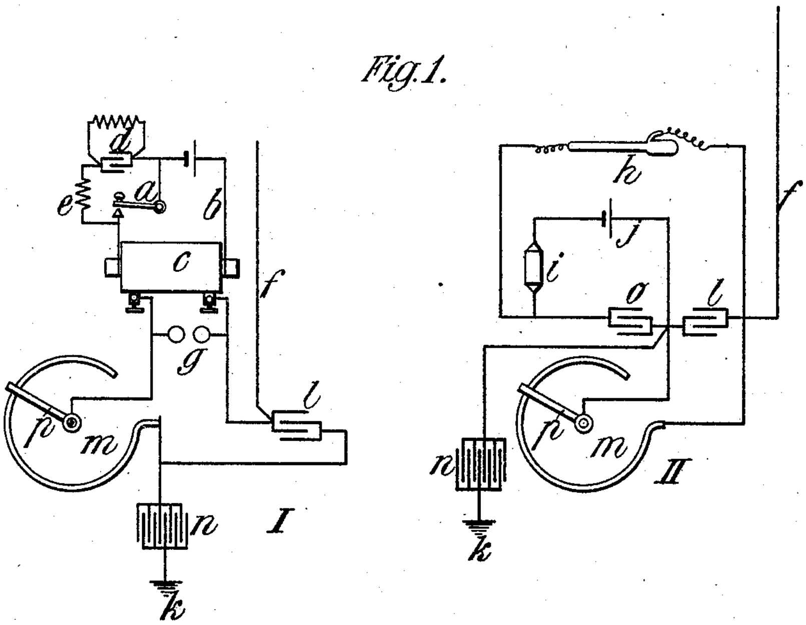
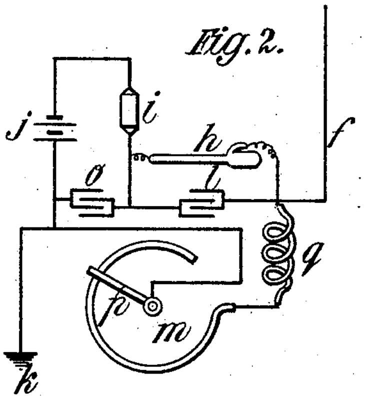


Fig. 2.



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SYNTONIC SPACE TELEGRAPHY.

No. 795,843. **Specification of Letters Patent.** Patented Aug. 1, 1905.

Application filed March 21, 1902. Serial No. 99,254.

To all whom it may concern:

Be it known that we, OLIVER JOSEPH LODGE, residing at Birmingham, in the county of Warwick, and ALEXANDER MUIRHEAD, residing at Shortlands, in the county of Kent, England, subjects of His Majesty the King of Great Britain, have invented new and useful Improvements in Syntonic Space Telegraphy, of which the following is a specification.

Our invention relates to systems of telegraphing by means of Hertzian waves and comprises certain improvements, hereinafter more specifically described and claimed, in the emitting and receiving circuit arrangements whereby greater certainty of action is obtained and other advantages secured.

In the accompanying drawings, Figure 1 is a diagram representing the instrumentalities and circuit connections of a Hertzian-wave system of telegraphy. Fig. 2 is a similar view of a modified form of receiving-circuit.

In the diagrams *a* represents the key or other means serving to close the primary circuit *b* of the induction-coil *c*. As shown in Fig. 1 there may be included in this circuit a shunted condenser *d* and resistance *e* for reducing the spark at the key. *f* represents the aerial conductor, "sky-wire," "wire appendage" or "capacity area" extending to the requisite height. *g* is the spark-gap of the emitting-station. *h* is the coherer, *i* the telegraphic receiver, and *j* the battery in the receiving-circuit; and *k* throughout the diagrams indicates the ground.

In Fig. 1 the Roman numeral I indicates the emitting-station and the Roman numeral II the receiving-station. In actual practice it will be understood each station may either emit or receive; it is usual to utilize the one sky-wire *f* for both purposes and to so arrange the connections that by means of a switch either the emitting-circuit or the receiving one may be connected to it. For the sake of clearness all this is omitted from Fig. 1.

In carrying out our invention we utilize three discoveries which were demonstrated by experiments by one of us and to which it will be necessary to refer before proceeding to describe our present invention (see the paper entitled *Experiments on the Discharge of Leyden Jars* by Oliver J. Lodge F. R. S. in Vol. 50 of the *Proceedings of The Royal Society.*) We refer to (1) an experiment called that of the "recoil-kick" wherein a long wire attached to a discharging Leyden-jar circuit was thrown into violent electric oscillation in synchronism with the jar, combined with (2) an experiment called that of "overflow" wherein a long wire appendage was used to set up oscillations in a Leyden-jar circuit and to cause it to overflow, combined also with (3) the "syntonic" Leyden-jar experiment discovered by one of us and first published in the magazine *Nature*, Vol. 41, page 368, where the oscillations of one discharging Leyden-jar or condenser circuit set up similar feeble oscillations in a distant Leyden-jar or condenser circuit precisely attuned to the first.

The wire referred to in experiment (2), in carrying out this invention, we use as an elevated or sky wire both for the sender and for the receiver and we detect the overflow by means of a coherer, as described in the book *Signaling Through Space Without Wires*, 3d edition, page 21, and see also pages 6, 22, 27 and 31, thereby enabling a very feeble overflow to be detected.

In carrying out our invention the coherer employed as detector of the Hertzian waves is connected to the receiving Leyden jar or condenser so as to feel and detect the overflow and at the same time to be protected from the direct action of the aerial conductor or of any pulse or sudden jerk collected by it about which there is no tune.

In a former United States Patent No. 609,154 granted to one of us a method of employing combinations of circuits of self-inductance with capacities is fully described and claimed in connection with the sending and receiving circuits of systems of syntonic telegraphy whereby signaling may be effected between any two or more correspondingly-attuned stations without disturbing other differently-attuned stations. And in the specification of the former English Patents Nos. 18,644 and 29,069 of 1897 granted to us various combinations of condensers and self-inductance circuits are described having for their objects either the protection of the coherer-circuit from undesired disturbances created locally or at a distance or the regulation of the syntony of the apparatus.

In none of the above-mentioned prior patents is the principle of the "recoil-kick" made use of in the design of the sending-circuit nor that of the "overflow" in the arrangement of apparatus in the receiving or "coherer" circuit.

As will be seen first from that part of Fig. 1 showing the emitting-station we employ in the emitting-circuit a condenser *l* the opposite terminals of which are connected through a suitable self-induction *m*, which may be a simple wire, or may be a coil, with a spark-gap *g*; which is excited in the ordinary way by the induction-coil *c* and trembling break, giving one spark for dot and two or more sparks for dash when the primary circuit *b* of the said coil is closed by means of a key *a*, which may be operated manually or automatically. One terminal of the condenser, *l*, has the aerial conductor *f* of appropriate length and capacity area reaching up to a considerable height connected to it and the other terminal of the said condenser is connected either to earth direct or through another condenser *n* to earth as shown in Fig. 1. In the receiving-circuit we employ a similar condenser *l* (see that part of Fig. 1 showing the receiving-circuit) closed through a similar self-inductance *m* but without any spark-gap, so that oscillations of great feebleness can begin in it and work up to something perceptible. The said condenser, *l*, when used for receiving, like the other when used for emitting, has an aerial conductor or capacity area *f* connected to it and reaching up to a considerable height to catch the pulses from the distant station and by means of them to excite and promote oscillations in the circuit of the condenser, *l*, to which it is attached; the other coat of the condenser, *l*, being earthed as usual. The said receiving-condenser, *l*, is provided also with an overflow-path, in which the coherer *h* is inserted for the purpose of detecting the overflow with the battery *j*, the telegraphic receiver *i*, and a subsidiary condenser *o*, for by this arrangement the telegraphic instrument *i* is able to indicate every cohesion caused by every overflow provided the coherer *h* is kept constantly automatically tapped back by clockwork or other mechanism as described in the prior United States Patent No. 674,846.

The object of the subsidiary condenser *o* is to act as a shunt to battery and receiver so far as sudden electric changes are concerned, and thus afford an easy path for overflow from the main condenser *l*; it does not necessarily form part of the oscillating circuit, and the amount of its capacity is immaterial so long as it is large enough not to throttle or interfere with the oscillations or with the free overflow of the condenser *l* into the coherer *h*, and so long as it is small enough to help protect the coherer from undesired disturbances collected by the aerial conductor *f*.

In order to provide efficient tuning or synchronism between the sending and receiving circuits, the length or self-induction of each condenser-circuit is capable of adjustment within certain limits by means of an arrangement such as sliding contacts or a revolving arm *p*, on the principle first described by one of us (see the book *Signaling Through Space Without Wires* at page 6) or it may be done in any ordinary way as by approaching or receding the spires of a coil or two portions of a coil, (see *q* in Fig. 2.)

Somtimes between the aerial conductor and earth we insert, as shown in Fig. 2, the two condensers *l* and *o* (of suitable capacity for their respective functions) in series and also the adjustable self-induction *m*. Only one of these condensers is intended to overflow, and with this one the terminals of the coherer are connected directly, as shown in Fig. 2, instead of through the supplementary condenser as in Fig. 1.

The condensers employed in connection with the emitting and receiving circuits are sometimes made of stout glass plates coated with tin-foil and the whole embedded in paraffin wax, or preferably of metal plates or cylinders submerged in oil or other insulating liquid.

The self-induction *m* in most cases consists merely of an almost complete circle of thick copper wire as shown, the circuit being closed by means of the spring copper revolving arm *p* which rotates about the center of the circle, merely varying its length for the purpose of the fine adjustment of tuning. For coarse adjustment this circular strip of copper is supplemented by an open spiral of thick copper wire, as shown at *q* in Fig. 2, or by any additional self-induction adjustable in any well-known way.

The action of an emitter upon a receiver constructed in accordance with this invention is as follows: The induction-coil *c* of the emitter charges the condenser *l* of the emitting-station and discharges it at the spark-gap *g* thus setting up oscillations in the circuit of the condenser *l* through the self-induction *m*, the frequency of which can be adjusted by varying the amount of self-induction thereof. The elevated conductor *f* which is attached to the discharging condenser-circuit through *l*, *m* and *g* is at the same time thrown into violent electrical oscillation in synchronism with the condenser *l* and these oscillation impulses are reflected by the elevated conductor at its upper end in a series of recoil-kicks each of which communicates to the ether a considerable disturbance resulting in electric waves which travel through space. On reaching the distant station II of Fig. 1 these waves set up oscillations in its elevated conductor *f*, which is attached to a condenser-circuit similarly attuned to that of the emitting-station, but without the spark-gap, wherein are set up similar oscillations which work up gradually in strength until they become strong enough to break down the resistance of the coherer: which happens so soon as the maximum potential attained by these oscillations in the condenser-circuit is high enough to cause an electrostatic overflow through the coherer *h;* the result being a diminution in the resistance of the latter and the formation of a signal on the receiving instrument *i* as is well understood. The battery *j* and receiver *i* in the overflow-circuit are shunted by a supplementary condenser *o* so as not to let them form an obstruction to the easy overflow into the coherer. The novelty in this part of the invention is the mode in which the coherer *h* is connected to the receiving condenser, *l*, so as to feel and detect the overflow and at the same time to be protected from the direct action of the elevated conductor *f* or of any pulse or sudden jerk collected by it about which there is no tune.

We find that the concentration of the stimulus on needle-points instead of on surfaces of finite magnitude as in the construction of coherers hitherto is advantageous.

We are aware that it has before been suggested to employ condensers in systems of syntonic Hertzian-wave telegraphy for other purposes such as the adjustment of the effective amount of inductance in transformers or self-inductance coils, but the function of the principal condenser *l* as hereinbefore explained by us is entirely different therefrom, it being employed by us in series with a self-induction of suitable amount to form a tuned closed condenser-circuit required in the system of syntonic telegraphy based on the principles of the "recoil-kick" in the emitting-circuit and the "overflow" in the receiving-circuit hereinbefore respectively alluded to.

What we claim, and desire to secure by Letters Patent of the United States, is—

1. In combination, in the receiving-circuit of a system of Hertzian-wave telegraphy, a condenser and a self-induction of suitable amount forming an attuned condenser-circuit closed through such self-induction, an elevated collecting-conductor, an overflow path, a coherer in such overflow-path, and a subsidiary condenser in shunt to the receiving instrument and its battery substantially as set forth.

2. In combination, in the receiving-circuit of a system of Hertzian-wave telegraphy, a condenser and a self-induction of suitable amount forming an attuned condenser-circuit, an elevated collecting-conductor, an overflow-path, a coherer in such overflow-path, and a subsidiary condenser in series with the main condenser and also in the attuned circuit, said subsidiary condenser being in shunt to the receiving instrument and its battery.

In testimony whereof we have hereunto subscribed our names.

OLIVER JOSEPH LODGE.
ALEXANDER MUIRHEAD.

Witnesses to the signature of Oliver Joseph Lodge:

HUME C. PINSENT,
HY H. OLIVER.

Witnesses to the signature of Alexander Muirhead:

A. F. SPOONER,
J. S. WITHERS.